#00-05 (Sep-Oct 00)

EUROGRAM

EUROPEAN OFFICE OF AEROSPACE RESEARCH AND DEVELOPMENT

CC HIGHLIGHTS

After a major effort from AFOSR's Contracting shop and the International Office, we now have a contracting vehicle that will allow us to use 6.2 funds for 6.2 work in the international arena. Cheers for AFOSR's Contracting Shop and the International Office (especially Capt Frank Dement) for creating, coordinating, and publishing a document that covers virtually all the 6.2 interests of AFRL.

This gives us a little more flexibility to support you in international projects. In the past, we were limited to processing basic research projects under AFOSR's 6.1 BAA, which had to be at least 51% 6.1-funded. If we were contracting for you, we still had to find funds to make the 51% 6.1 funding threshold, or we both were out of luck. Now, we can legitimately use your 6.2 funds for projects you deem to be 6.2.

For your information, we can still use 6.2 funds you provide for 6.1 research. We will ask you to provide us with documentation that states in your opinion your already-approved 6.2 project requires basic research on one or more aspects this particular proposed 6.1 program meets your need. We will need the name of your 6.2 program and a statement that the program is described in your annual Descriptive Summary. It's your responsibility to document on your MIPR that the funds are being used correctly.

Now it's your option. Please look at AFOSR's International BAA at
http://www2.eps.gov/EPSData/USAF/Synopses/1542/AFOSR-BAA-2000-4/AFOSRBAA2000-4.pdf
and decide if you want EOARD or AOARD to contract for your 6.2 research overseas. If you want basic research done with your 6.2 dollars and/or the work you want done fits under AFOSR's 6.1 BAA, you need to document why the use of 6.2 funds are appropriate and for which already-approved program.

As we wind up the end of another busy fiscal year, EOARD bids a reluctant farewell to Dr. C. Martin Stickley, our Chief of Lasers and Optical Materials. He leaves us after three years as one of EOARD's most effective and productive Program Managers. Martin and his wife, Dottie, are heading home to Winter Park, Florida. Martin will return to the faculty of the School of Optics and the Center for Research in Optics & Lasers (CREOL) at the University of Central Florida in Orlando. His new contact points will be telephone: 001-407-823-6800 -- fax: 001-407-823-6880 -- email: cms@creol.ucf.edu

And now for the headlines:

- *Feature article:* Window on Science visits – Host Guidelines
- NASA, AFRL visit Russian pulse detonation engine research
- Sokolov presents Raman Generation by Phased and Antiphased Molecular States
- Report from the 20th International Laser Radar Conference, Vichy, France
- Highlights from Farnborough 2000 Air Show
- French Space Research Center announces intent to collaborate internationally in microsatellites

For the Commander

Robert S. Fredell, Lieutenant Colonel, USAF
Technical Director, EOARD

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Feature Article

Window on Science (WOS) Visits – Host Guidelines

Window on Science visits have to be considered in the broader picture of overall national security and export control. Due to several high-profile cases of espionage and export control failures (none, thankfully, were from WOS), the US Government has increased manning for security and export control and increased emphasis on these topics. The Window on Science program is under scrutiny because of the high volume of foreign visitors we create (about 550 visitors to nearly 1000 sites in the last two years!) and the subsequent potential for problems. SAF/IAD recently published an advisory on their website, aimed primarily at AFRL foreign disclosure offices, to assist them with WOS visits. If you have seen this advisory, the number of restrictions and required actions are intimidating. The reality is that very little has changed. We and YOU (we hope) have been complying all along.

A WOS does not take place unless there is a local host who is willing to take responsibility for the visit, i.e., you. Part of that responsibility is to work with the local foreign disclosure office to create a security plan for the visit and to ensure the plan is followed. We, EOARD and AOARD, send an e-mail with the visit details to SAF/IAD, the local foreign disclosure office of the base visited, AFOSI, and the Defense Threat Reduction Agency (for visitors from the former Soviet Union). We currently have a verbal agreement with HQ AFOSI that they will notify the local AFOSI office. SAF/IAD has agreed that we may still assume approval for the visit, unless you hear differently. If someone has a concern about your incoming WOS, you will hear about it. The process does work.

The visit guidelines haven't changed that much either. We are authorized to *receive* briefings and demonstrations from the foreign scientists and conduct public domain discussions. Discussion of articles in published scientific journals is authorized. Discussion of your 6.2 and 6.3 research efforts most likely is NOT. We hope that the visitor created enough interest that you will discuss the possibility of a basic research contract with that individual. You can speed the contracting process and improve your final product if you can agree to the contract details while face to face, rather than by prolonged, multiple e-

mailings. Also, do keep a copy of the briefing presented to you; most likely the foreign disclosure office would like a copy. SAF/IAD has been following up on our visits lately.

Another concern of yours should be to avoid what's called a "deemed export." This occurs when your foreign visitor, without an approved export license, receives a briefing, or simply sees materials, equipment and/or data that is covered by export controls. SAF/IAD repeatedly has shown that when they visit the lab sites and walk the proposed tours, that they can point out equipment from operational systems, tech manuals, briefing charts posted on walls, etc., that are covered by export controls. Hence their general prohibition on tours of our lab facilities. Plan on helping the visitors come on base and walk by a pre-"cleared" path to a conference room or other "general purpose" area for their presentation and discussions.

If you are conducting basic research at your facility, and if you are absolutely positive you can get the visitor into and out of that area without disclosure, and if by doing so you have increased your understanding of the visitor's briefing or the visitor's understanding of a potential follow-on contract, then do ask your local disclosure office to help you get that included in your "approved" security plan for that visit. SAF/IAD is very cooperative when given full information, but the responsibility to provide sufficient information is yours.

We do expect you to be gracious hosts for these visitors who have traveled around the world to brief you on their work. Many of these visitors need help cashing the small honorarium checks we provide, and in finding local lodging. All appreciate advice/company at the local eating establishments. Be social! However, remember that these individuals were paid by AF S&T dollars to make these visits and the majority of them are hopeful for a research contract from us. They already have been compensated for their journey (travel, lodging, meals and incidentals, etc.).

The Window on Science program is a valuable tool for you to learn about leading edge research going on outside the US and to improve the communication process for future basic research contracts. However, national security is obviously a higher priority. You can do both.

PROGRAM MANAGER REPORTS

Lt. Col. Rob Fredell
Technical Director

Site Visit: Delft University of Technology, the Netherlands, 14 – 16 August 2000. This visit was made to review progress on a number of aging aircraft/sustainment-related activities and plan for a TU Delft–provided composite short course to be offered at the USAF Academy in summer 2001. The primary host and POC was Dr. Arie Vlot, who discussed the status of the following contracts:

- *Further development of the bonded repair model CalcuRep.* This contract supports the effort by the Center for Aircraft Structural Life Extension (USAF Academy) and the Aging Aircraft Program Office (Wright-Patterson AFB) to further develop a user-friendly, PC-based model for the design of bonded composite repairs to cracked aluminum structures. The model will be unique in that the user will have several crack-patching models to choose from. Further, the software will feed its results directly into fatigue crack growth models such as AFGROW to allow damage tolerance calculations to be made and inspection intervals to be set on the repair.
- *Structural Modification of Fuselage Riveted Lap Joints Through Force-Controlled Riveting.* This contract extends the work of Müller and Hart-Smith who have shown the tremendous positive impact on the fatigue life of aircraft structures of something as "mature" as the squeeze force applied during the riveting process. The contract will look at the effectiveness of extending the fatigue life of aging aircraft by re-squeezing the existing rivets in a fuselage lap joint.

I explored the plans for staff members of the Center for Lightweight Structures at Delft to provide the hands-on

short course "Affordable Composites: Design, Analysis, and Manufacture," to be presented at the USAF Academy in July 2001. The course will focus on the holistic approach developed by Prof. Adrian Beukers and his group for applying vacuum-assisted Resin Transfer Molding to producing aerospace-quality composite structures for 1/10th the cost of structurally equivalent autoclave/prepreg components. The Delft group will provide design and analysis software, mold design software, and hands-on training in the technology. For course dates and availability, contact Lt Col Jim Greer, jim.greer@usafa.af.mil

Site Visit: Contract kick-off meeting, Laboratory of Photonics and Interfaces, Ecole Polytechnique Federal de Lausanne (EPFL), Switzerland, 22 August 2000. The primary host and POC was Professor Michael Graetzel. The meeting involved EPFL, EOARD, and AFRL/MLQC personnel and acted as a formal start to this contract to research flexible thin film molecular photovoltaics.

Photo-electric conversion by conventional solar cells involves minority charge carriers whose lifetime is restricted due to recombination. Currently, the dye sensitized solar cell (DYSC) provides the only technically and economically credible alternative to conventional p-n junction photovoltaic devices.

This proposed configuration has several advantages over the state-of-the-art electrolyte-based cell. Most important, higher open circuit photovoltages can be achieved that result in less sensitizer excitation energy sacrificed as heat.

The open circuit voltage of the electrolyte-based cell is typically 0.75 mV, while the threshold excitation energy of the standard sensitizer is 1.6 V. Increasing the open circuit voltage of the cell by using a well-matched solid hole conductor is critical for obtaining high conversion efficiencies approaching 20%. A second advantage of the solid state cell is the possibility of making flexible devices based on plastic support materials. The low weight of such cells would make them particularly attractive for aircraft applications (e.g., solar-powered UAV aircraft) and for air-deployable electric power systems for bare base deployments. Depending on space durability concerns, flexible thin film molecular photovoltaics could provide an additional satellite power source as well.

Guest contribution: Conference Attendance: 22nd International Congress on Aeronautical Sciences, (ICAS), Harrogate, United Kingdom, 27 August - 1 September 2000. The local host was the Royal Aeronautical Society; sponsors included EOARD, BAe Systems, Rolls Royce, DERA, Rockwell Collins and others. The conference offered a broad range of aeronautical topics, ranging from fundamental research to operational studies for military and commercial aeronautical topics.

From 500 candidate papers, a comprehensive program of about 280 papers were presented, and are available on CD-ROM. At Wright-Patterson AFB, Mr. Joe Manter, Dr. Narendra Khot and Dr. Roger Kimmel have CD-ROMs.

AFRL was well represented at the conference:

- Joe Manter, AFRL/VA, Session Chairman 4.1, Composite Materials, Design & Analysis
- Don Paul & Joe Manter, AFRL/VA, co-authors 4.3.2, "Airframe Structures Technology for Future Systems"
- Roger Kimmel, AFRL/VA, Session Chairman 3.4, Transition & Turbulence
- Narendra Khot, AFRL/VA, author 1.4.1, "Flexible Composite Wing with Internal Actuation for Roll Maneuver"
- Joe Manter, AFRL/VA, presenting Jack Lincoln's (ASC/EN) paper 4.4.2, "Effect of Aircraft Failures on USAF Structural Requirements"
- Vickie Tischler and V. Venkayya, AFRL/VA, co-authors with Sensburg & Schweiger of DaimlerChrysler, paper 4.7.4, "A Carbon Composite Diverging Vertical Tail for Commercial Airplanes."

Some highlight papers in the conference included:

- *for CFD experts in turbulence modeling*: "CFD for Aerodynamic Turbulent Flows: Progress and Problems," (The Guggenheim Memorial Lecture), Professor B. E. Launder, UMIST, UK
- *for all aerodynamicists:* "Future Challenges and Opportunities in Aerodynamics," by A. Kumar and J. Hefner, NASA Langley
- *for virtual prototyping fans*: "Global Integration and Management of 21st Century Fighters," by Lockheed-Martin engineering Vice President Charla K. Wise.

Dr. Charbel Raffoul
Aeronautics

Site Visit: **German Aerospace Center** (**DLR), Koeln-Porz, Germany.** DLR is Germany's national aerospace research center as well as the national space agency. This visit was made to the Institute of Propulsion Technology headed by Dr. R. Schodl. The group has highly talented engineers and physicists with special knowledge in Optics, Electronics, Spectroscopy, Lasers, Particle Generation and Sizing, Light Guide Fibers, Photodetectors, CCD-cameras, Digital Image Processing, Experimental Thermodynamics, Data Processing, and Process Control. The group objectives are the development and application of laser optical measurement techniques for the aero-thermodynamic of aero-engine components. Specifically:

- Development of measurement systems with specific application requirements
- Performing in-house measurement applications
- performing measurement campaigns on customer contract in house or at customers site
- Design and adaptation of test rigs for measurement application

These tools are designed for various special applications, such as stationary and periodically non-stationary reacting and non-reacting flows in axial and centrifugal compressors, axial and radial turbines (rotor and stator), cascades, flames, combustion chambers, nozzles, pipe flows, wind tunnels and in-flight applications.

The measurement techniques that are being developed at DLR Cologne are:

- *L2F - Laser Two Focus (or LT - Laser Transit) Velocimetry* for point measurements of flow velocity based on light scattering of particles.
- *CARS - Coherent anti-Stokes Raman Spectroscope* for point measurements of static gas temperature and molecular concentrations.
- *DGV - Doppler Global Velocimetry* for planar measurements of flow velocity based on the analysis of the Doppler frequency shift of light scattered by particles.
- *QLS - Quantitative Light Scattering Technique* for planar technique based on Mie scattering for quantitative concentration measurements of mixing flows.
- *TSV - Tracer based Shock Visualisation* a planar technique based on Mie scattering to visualize the position and structure of compression shocks in transonic flows.
- *PLIF - Planar Laser Induced Fluorescence* for visualisation and quantitative analysis of selected species in gas and liquid phase by planar laser induced fluorescence imaging measurements in high pressure spray flame combustion.

The status of the DGV technique is quite impressive. The system has been optimized for 3-component mean value measurements. The results are a high measurement accuracy - about 1 m/s. The system is configured from one DGV-Camera system and three light-sheets established successively from different directions. The group has extensive experience in applying the technique in confined flow applications.

By combining the principles of L2F-method and DGV, they have also developed a so-called Doppler-L2F-system that allows three-component velocity measurements from one viewing direction. A probe (backscattering type) L2F-system was developed with a 14 mm diameter and a 60 mm probe throw. Bigger systems with wider working distances are also available.

The group is also interested in the iodine filtered Rayleigh scattering technique for temperature measurements, and DGV application for confined high-speed flows.

Conference: **The 2nd Workshop on Magneto-Plasma Aerodynamics for Aerospace Applications, Moscow, Russia, 5-7 April 2000.** The 2nd Workshop on Magneto-Plasma Aerodynamics for Aerospace Applications was held in Moscow at IVTAN (Institute of High temperatures of Russian Academy of Sciences). Organized by IVTAN under the Scientific Council for Direct Energy Conversion and the Scientific Council for Fluid Mechanics both of the Russian Academy of Sciences, the Workshop sponsors included EOARD, RFBR (Russian Foundation for Basic Research), ILG MHD, SEAM (USA) and MTC. Attended by about 150 registered participants, the workshop included 14 specialists from USA (Boeing Co, USAF, NASA, Princeton University), UK, Italy, Israel and 50 Russian specialists.

The theme of this workshop, a follow-on to the first Workshop held in March 1999 (see Eurogram #00-04 Jul-Aug 00), was the fundamental aspects of magneto-plasma aerodynamics in relation to applications of magneto-plasma aerodynamics processes and their effects in the Aerospace Research & Development.

Several decades of intensive programs for MHD energy conversion; physics of gas discharge, research and development of miscellaneous gas discharge devices, physical gas dynamics, and the physics of shock waves form the scientific and technical background in this field. IVTAN as one of the leading organizations of the Russian Academy of Sciences took the initiative to manage such an international meeting.

The Workshop contained sessions in:

- plenary,
- MHD flow control,
- MHD electrical power generation,
- plasma aerodynamics,
- plasma generators,
- shock wave propagation in gas-plasma media,
- magneto-plasma aerodynamics effects in wind tunnels.

About seventy technical papers were presented in Russian with synchronous translation into the English (English presentations were translated into Russian). The proceedings are being translated into English and will be available in late September. Copies will be mailed to all participants.

Fourteen speakers participated in a round table that discussed and formulated the results of the 2nd Workshop. Remarkable growth in the quality of the technical presentations and the formal and informal discussions was recognized. All attendees recommended the workshop series continue since it compliments the US-based Weakly Ionized Gas Workshop. The 3rd Workshop will be held at IVTAN Moscow in early April 2001.

Dr. C. Martin Stickley
Laser, Optics and EO Materials

Conference: 2nd Int'l Symposium on Optical Power Limiting, Venice, Italy, 2-5 July 2000. This conference was a follow-on to the first in this series held in Cannes, France in 1998. The greatest number of contributions were from was France (14), followed by Italy (12) and the US (10). A total of 16 countries were represented including India, Korea, and Australia. The conference was dominated by papers on the chemistry of molecular systems that might exhibit strong reverse saturable absorption and two-photon absorption. Not being a chemist, it is hard for me to critique these papers. On the device side, Richard Hollins provided an excellent overview of "Goals, Architectures, and Materials for Broadband Eye Protection," and he will provide the interested reader with a copy of his viewgraphs. He can be reached at rchollins@dera.gov.uk

An excellent paper on advanced protection device design and operation was given by Eric VanStryland (ewvs@creol.ucf.edu):
"Cascaded Optical Limiters and Modeling: We have successfully demonstrated an optical limiting device that limits the output energy through a 1.5 mrad aperture angle to below 1 microjoule for input energies up to 9 mJ. This device is based on a cascaded focus geometry (two separate foci) using different nonlinear optical materials at each focus: liquid carbon disulfide at the first focus and the reverse saturable absorber dye, lead phthalocyanine (PbPc) in solution at the second focus. The PbPc protects sensitive optical detectors from damage for low inputs while the carbon disulfide protects the solution-filled cell for high inputs. This combination results in a clamped output over more than a three order of magnitude change in input energy."
VanStryland stated that this device has a dynamic range of over 7500, a factor of 10x better than before. He thinks it will work for pulse lengths as long as 30-50 nanoseconds but probably not for femtosecond pulses.

The proceedings are to be published by Gordon and Breech as a special issue of Nonlinear Optics.

Conference: 20th International Laser Radar Conference, Vichy, France, 10-14 July 2000. After more than 30 years of development, laser radar systems have evolved into highly useful systems for remotely sensing properties of the atmosphere from both space, aircraft, and ground platforms. Applications range from automatic remote weather sensing to cloud height measurement; from satellites to 3D mapping and the profiling of cities. Laser technology is moving out of the phase of demonstrating that a specific measurement can be done from a selected platform to optimizing the laser design in order to minimize size, weight, power requirements, and the need for hands-on operation. While other techniques can be used for atmospheric profiling, the laser's unique features are tropospheric profiling and high resolution at high altitudes.

NASA Goddard is leading the way in developing an autonomous, low-power atmospheric lidar that will operate continuously in a temperature-controlled enclosure, charge its own batteries through a combination of a small, rugged wind generator and solar panels, and transmit its data from remote locations to ground stations via satellite. A network of these

instruments is being established in the Antarctic. The snow is kept off its windows by keeping the windows absolutely smooth and locating them well above the ground. If this is done, the wind will keep the window clear. The laser being used in this system is a Nd:YAG microchip design originally developed at the Air Force's MIT Lincoln Laboratory.

Allan Carswell of Optech Inc. in Toronto (allan@optech.on.ca) gave a very interesting talk on commercial applications of lidar-related technology. First, he showed 3D maps of Baltimore, MD that were taken with a 1.54 micron eye-safe lidar mounted in a small airplane. The 3D profiles were remarkably detailed and indicate that this survey technique will certainly replace the ones currently used by civil engineers. The data were sent by telemetry to a data bank; this data could be manipulated to enable the user to dial-up any desired view. Such systems are also far better than the conventional methods of mapping shallow water regions near shorelines. Second, Optech has developed a system for removing trees and doing ground mapping from an airborne reconnaissance vehicle. This vehicle carries a laser with ultrafast, high dynamic range return-signal processing. This works in situations where the tree cover is 99% complete (or perhaps higher). While they have not used it for target identification, it certainly seems possible that it would work for this application, thus enabling the USAF to find targets virtually covered by trees. Third, Optech is developing light-weight, unfolding mirrors for deployment from a satellite. Their technology should be of considerable interest to AFRL where similar technology is under development.

Conference: 9th International Laser Physics Workshop, Bordeaux, France, 17-21 July 2000. This conference is unusual in that it is organized primarily by Russian laser physicists but held outside of Russia. Previous meetings have been in Prague, Berlin, and Budapest. The topics covered by this meeting included Quantum Nucleonics and Short-Wavelength Lasing, Strong Field Phenomena, Cold Atoms, and Laser Methods in Medicine and Biology. Proceedings will be published in the January 2001 issue of the Journal of Laser Physics, which is published in Moscow.

In Laser Physics these days, the hottest topic is the development and application of femtosecond pulse technology (a femtosecond is 10^{-15} second). Laser systems can be purchased from commercial suppliers that produce pulses of 10 fs or so in duration. Single pulses may be produced having millijoules of energy resulting in powers in the terawatt level. Average powers of more than 10 watts can be produced with pulse lengths of 700 fs, and pulse rep rates of 60 GHz have been achieved.

Of the many interesting papers, two stand out. The first was by the group at Vienna University of Technology on
"Absolute Phase Control of Few-cycle Laser Pulses: Using a coherent nonlinear optical technique, measurement of the temporal evolution of the absolute phase of sub-6-fs wave packets has been demonstrated, permitting the generation of intense, few-cycle light with precisely reproducible electric and magnetic fields for the first time. These pulses open up the way to controlling the evolution of strong-field interactions on the time scale of the light oscillation cycle and are indispensable for reproducible attosecond x-ray pulse generation."
As such pulses are almost always generated in a pulse train, the control of the phase of the light within the pulse envelope must be locked to the phase of the envelope so that the "user" of these pulses will always see the same electric field amplitude in the pulse envelope. If this does not occur, nonlinear interactions will be irregular and nonreproducible as the peak electric field will be different for each and every pulse. The Vienna team reported achieving a 50 ppm phase locked stability.

The second paper of note, and arguably the best one at the conference, was presented by a young Russian physicist, A. V. Sokolov (sokol@leland.stanford.edu), working at Stanford University with Prof. Steve Harris:

"Raman Generation by Phased and Antiphased Molecular States: We propose and analyze a technique for producing subfemtosecond pulses of radiation. The essence of this technique is the use of a Raman transition with a sufficiently large coherence that the generation length and phase-slip length are of the same order. This coherence is established by driving the molecular transition with two single-mode laser fields slightly detuned from the Raman resonance so as to excite a single molecular eigenstate. Molecular motion, either in phase with the driving force (Raman detuning below resonance) or antiphased (detuning above resonance), in turn modulates the driving laser frequencies, causing the collinear generation of a very broad FM-like spectrum.

"In our experiment, we use molecular deuterium to demonstrate collinear generation of mutually coherent equidistant sidebands, *covering 50,000 cm-1 of spectral bandwidth and ranging in wavelength from*

2.94 microns to195 nm. We show that, in agreement with theory, generation maximizes at a finite detuning on either side of the Raman resonance. We demonstrate a good beam quality and a perfect relative coherence of anti-Stokes Raman sidebands with respect to the driving fields. This mutual coherence among the sidebands will allow us to recombine them and use spectral modification techniques to synthesize any specified subfemtosecond time structure in a target cell."

Sokolov has attained hundreds of microjoules in a pulse. Measurement of the pulse duration has not been done as there is no substance with which this pulse can interact that will have the bandwidth to enable a true measurement, but theory predicts that the pulse duration should be 0.2 fs.

Site Visit: Gesellschaft zur Forderung angewandter Optik, Optoelektronik, Quantenelektronik, und Spektroskopie e.V. (GOS), Berlin, Germany. POC: Prof. Dr. Gunter Henrion, Chairman of the Board, ghenrion@aol.con. Founded in 1990, GOS is an incorporated society whose dues-paying members are employed at Berlin science and technology institutes. GOS, through the efforts of its members and leadership, seeks opportunities for R&D contracts that will build on the capabilities of its members working at their institutes. Funding of a project by another firm or government entity enables the member to hire others to work with him or her on this specific project. The annual funding that flows through GOS amounts to about four to five million DM (US $2M) per year. GOS has a paid staff of four that negotiates contracts and handles their administration. GOS has 35 members associated with 16 institutes and industrial firms. Many are located in the Aldershof region of Berlin. Over the 1990s, this region has developed into a large research and industrial park. Membership development in GOS and in the Berlin-Aldershof region is led by WISTA Management GmbH, Berlin, the Berlin-Aldershof Science and Technology Centre.

I visited with three of the organizations having employees who are members of GOS. The first, the Ferdinand-Braun-Institut for Hochstfrequenztechnik, is led by Dr. Gunther Trankle, trankle@fbh-berlin.de. Dr. Trankle sees that the role of his institute lies between that of German universities, where new things are developed with little idea as to their value, and German industry, where little new is developed and product improvement is carried out on products with well-understood values. They carry out applied research on microwave- and optoelectronics-based GaAs technology:

(a) heterojunction bipolar transistors and MESFET MMICs are developed and used in mobile communications devices and sensors; and
(b) semiconductor lasers are developed and applied in optoelectronic measurements, medical systems, and diode pumping of other lasers.

The second institute was the Berlin-Alderhof Research Center of DLR, the German Aerospace Research Establishment, having a strong focus on sensing technology in space. Specifically, I met with Prof. Dr. Herbert Jahn, the Head of Passive Sensor Systems (www.dlr.de/Berlin) in the Institute of Space Sensor Technology and Planetary Exploration. They have developed 'push broom' and matrix cameras operating in the visible and near-IR using silicon CCDs, and in the far-IR using mercury-cadmium-telluride. These are applied to airborne digital sensors, and small satellites. For example, they have built a 4-kg camera with a 1-meter resolution from 4000 m altitude. They also can apply such technology to automatic fire detection in forests. They carry out modeling and simulation of sensor systems, signal and image processing, sensor design and optimization, and space systems control.

The Institut für Spektrochemie und Angewandte Spektroskopie was formed in 1951 and carries out fundamental and applied research on analytical techniques and instruments for solving environmental, medical, and industrial problems. I visited Dr. Helmut Becker-Ross, the head of the Laboratorium für Spektroskopische Methoden der Umweltanalytik (http://berlin.isas-dortmund.de), and the Vice-Chairman of GOS. He has been leading the development and application of echelle spectrometers that can present spectral data in a square format that matches a matrix of charge-coupled-device (CCD) detectors. Such detectors have improved tremendously in the past years: the photometric parameters of individual pixels (quantum efficiency, dark current, read-out noise) are comparable to or better than photomultiplier tubes. Further, the large number of pixels enables the complete and simultaneous recording of selected spectral ranges. Thus spectrometers are being redesigned and optimized accordingly. This group has shown that specially designed echelle spectrographs with internal order separation are the most suitable optical arrangement for the exploitation of solid-state detectors.

Mr. Peter Ouzts
NASA Liaison

Site Visits: Five Institutes/Universities in Russia involved in Pulse Detonation Engine research, Russia, 10 – 18 May 2000. A combined NASA Goddard, AFRL/PR, GE Aircraft Engines, and EOARD team traveled to Russia on a series of visits to Russian research institutes and universities with advertised expertise in Pulse Detonation Engine (PDE) research. The team members were: K. Breisacher, J. Doychak, S. Thomas (NASA GRC); F. Schauer (AFRL-PR); L. Butler, V. Raschupkin (GE Aircraft Engines), I. Leyva (GE Corporate Research); P. Ouzts (Air Force EOARD, NASA GRC).

The Institute of Mechanics, Lomonosov Moscow State University (LMSU), Moscow. Experimental hardware that uses gaseous fuel was displayed, while hardware that has used kerosene had been disassembled (restoration/upgrades would be required before resuming operational testing). A two-stage process was described where deflagration as the 1st stage involved a short duration (milliseconds), quasi-steady ignition of fuel/air required to prepare a detonable mixture, with delivery for single-pulse controlled by a diaphragm burst at pre-selected pressure. Continuous operation would require controlled steady-stream of kerosene decomposition products. The 2nd-stage detonation process involved a pulsed injection of products into a spherical half-closed cavity with ignition achieved by shock focusing. At least one data point was observed with a pressure rise from 4 to 25 atmospheres, which is sufficient to start detonation rather than just fast combustion. Some concern was raised regarding the lack of instrumentation/ high-resolution transducers. Issues regarding controlling the device were not yet explored while computations have been conducted for a cold (non-reacting) model. A reacting model is also being worked. Life issues (i.e. high cycle fatigue) have been considered to date although not in the context of a realistic system application.

The Institute for High Temperatures of the Russian Academy of Sciences (IVTAN), Moscow. Multi-stage detonation was described with pressure amplification achieved through decoupling/recoupling of the shock and flame front using area changes in the detonation tube. Pressure amplification could increase cycle and/or ejector efficiency. The geometry (area change) is dependent on the frequency and chemistry of the device. Only gaseous fuels had been tested, liquid fuels would require further geometry optimization. Fuel additives for detonation enhancement/suppression had also been assessed. A unique valveless operation was described using the detonation wave for control. There were some issues with shock detonation boundary layer effects on the deflagration to detonation transition. Also discussed was a steam reforming process where a pre-conditioned fuel (methane) was decomposed into H2, CO to enhance detonability. Ring acoustic cavities and Hartmann cavities were explored to perturb jets of fuel/air mixture for reducing initiator length. Finally, a production PDE for removal of rubber from steel-belted tires was described (video) as a water-cooled device, operating at long-duration and low frequency operation (4 hr. at 3 Hz). This would provide a more desirable means of tire destruction.

The Central Institute of Aviation Motors (CIAM), Moscow and Turaevo. CIAM expressed interest in PDEs and PDE rockets (PDREs) as an access to space, as a combined cycle propulsion system and as a primary driver for pulsed ejectors. Their research indicated only hydrogen-fueled concepts and they provided some vague CFD results of prior efforts. They have developed a pulsed rocket primary driver for an ejector (up to 2 tons thrust) with practical use as a hammer. This resulted in weight savings of 100X. The Turaevo facility was mainly a tour of CIAM's extensive facilities for propulsion testing of all kinds, with some of the facilities having unique capabilities.

The Kurchatov Institute, Moscow. This was a dinner meeting with Professor S.B. Dorofeev, Department Head, Institute of Applied Chemical Physics. Prof. Dorofeev evidenced his long-term experience in detonation phenomena particularly related to the nuclear industry.

The Siberian Division, Russian Academy of Sciences, Akademgorodok, Novosibirsk. The main attraction here was a Continuous Detonation Engine (CDE) device. The hardware for the "Pancake" CDE device was 12" diameter pancake-configured combustor mounted on a thrust stand similar to Povenelli, et al. (circa. 1960's) hardware at NASA Lewis Research Center to study combustion instabilities. It uses a circumferential injection of impinging elements, a clear (quartz?) top plate for viewing, and a central nozzle in the backplate for exhaust. A pulse gun is used to initiate high-amplitude combustion instability, transitioning into a continuous detonation wave as it propagates into the incoming propellants. Another annular CDE device was an approximately 1½" annular ring with a central plug. A larger (approx. 5") annular ring was said to have been

tested with a pulse gun used for initiation, thermally-choked (i.e. constant radial dimensions) with a small expansion lip. Ranges of fuel/oxidizer mixtures have been tested, including kerosene/oxygen.

The site visits to the above institutes/universities were deemed very successful by all involved. Significant expertise in PDE-related knowledge and technology exists in Russia. Specific novel concepts and approaches, which may potentially hold the near-term key for applications of PDEs to address NASA missions, were observed. If interest in funding some of these Russian activities materializes, NASA will coordinate efforts with and through AFRL and the ISTC.

Based upon the site visits a series of Windows on Science visits are in process for selected researchers. These researchers are expected to visit NASA GRC and MSFC, and AFRL/PR sites. In addition, NASA GRC is planning a PDE workshop to be held at GRC in May 2001. It is expected that EOARD may sponsor invited European/Russian researchers to this workshop.

Conference: 28th International Symposium on Mechanics on Combustion, Edinburgh, Scotland, 31 July – 4 August 2000. Hosted by the Combustion Institute, this annual conference covers the spectrum of combustion science from reaction kinetics to applications (IC and gas turbine engines). The conference included 240+ papers as well as more than 600 poster contributions. The contributing and attending audience represented 25 countries. True to its comprehensive nature, technical sessions were presented in the following areas:

- Combustion Dynamics;
- Instabilities and Active Control;
- Combustion of Solid Fuels;
- PF, FBC, and Waste Incineration;
- Detonations, Propellants, and Supersonic Combustion;
- Fire Research, Flame Spread, Fire Suppression;
- High Intensity Combustion, Gas Turbines, Practical and Innovative Systems;
- Internal Combustion Engines;
- Materials Synthesis and Catalytic Combustion;
- NOx, SOx, and Pollutant Emission;
- Reaction Kinetics of Combustion;
- Soot, PAH and Air Toxics;
- Spray and Droplet Combustion;
- Turbulent Non-Premixed Combustion; and
- Turbulent Premixed and Partially Premixed Combustion.

Plenary sessions presented the challenges to combustion science which must cover supersonic flight to wood-burning stoves, coal and solid fuel combustion, dynamics of combustion fronts (including detonations) in premixed gases, optical diagnostics for development of direct-injection engines, and interaction of combustion with the atmosphere (i.e., why we should care about high altitude emissions).

Specific areas of interest included detonations and supersonic combustion. The NRL and Stanford University presented two papers dealing with pulse detonation engines. The former dealt with the contentious issue of PDE performance with the conclusion that analytic computations of specific impulse are highly dependent upon the treatment of pressure relaxation at the tube exit. From the questions proffered by the audience following the paper, the performance of PDE, both at a component and system level, remains an area of much contention. It did not appear that this paper conclusively addressed the discrepancy in the various PDE performance claims. The latter paper discussed diode-laser absorption spectroscopy techniques applied in-situ to PDE experiments. This diagnostic capability will enhance modeling and optimization efforts. There were no foreign contributors in the PDE area although a recently concluded detonation workshop had been held in Moscow. In the same session, several contributions from Japan on supersonic combustion included a paper on developing criteria for flame holding in a H_2 fueled scramjet engine.

A group of NASA Goddard researchers, primarily interested in the issues of combustion in microgravity environments, attended the conference. Several potential WOS visits were discussed with this group as well as potential for NASA and AFRL cooperation in this area.

Dr. Jay Howland
Physics and Energetic Materials

Site Visit: Fraunhofer Institute of Chemical Technology, Karlsruhe, Germany, 9 August 2000. Dr. Fred Volk, Associate Director of the Fraunhofer Institute of Chemical Technology, organized the meeting to highlight their facilities and areas of expertise in energetic materials. The facilities and test ranges are remotely situated on top of a mountain, which allows them to control access and minimize

hazards to the German population. They can prepare samples of GAP, RDX, HMX, CL20 and various other energetic materials up to several kilograms. These materials are then characterized, mounted into various bodies or test fixtures and ignited in an instrumented test range. Instrumentation includes burn rate, mass spectrometers, and high-speed video cameras used to analyze the burn. There are many computer-controlled environmental chambers to conduct accelerated aging, to simulate shelf life' and determine long-term stability issues. The Fraunhofer Institute also has extensive knowledge of high-performance coating on materials. Other research programs include investigating the performance of nanomaterials.

Lt. Col. Dave Burns
Astronautics

Air Show: Farnborough International 2000, Paris France, 24-29 July 2000. The air show is held on alternate years from Le Bourget (Paris). Of note at this year's show was the Eurofighter flight demonstration, the DERA vectored thrust aircraft (static display), Su-32 static display and flight demonstration, and the Swedish Airborne Early Warning system (S100B).

The Eurofighter flight demonstration included a very impressive high angle of attack/low airspeed maneuver. The afterburner plume was visible for much of the demonstration.

DERA's VAAC (Vectored thrust Aircraft Advanced flight Control) Harrier was displayed. This aircraft is claimed to be the most capable and unique system in the world for studying control concepts for powered lift aircraft. Trials of advanced STOVL (Short Take Off Vertical Landing) control law development for shipboard operations have been underway since January 2000. These trials will support the US/UK Joint Strike Fighter (JSF) program.

(http://www.dra.hmg.gb/html/news/events/farnborough_international_2000.htm)

The Russian Su-32 fighter/bomber (variants include the Su-27, 30, and 34) was on static display, and also flew during the show. The Su-32, which with its side-by-side cockpit bears a strong resemblance to the F-111, is intended for the deep strike mission. It has a large tail boom with a rear-facing radar. The flight performance was flawless, but no exceptional maneuvers (such as high angle of attack) were demonstrated. The Russian air force is planning on replacing the Su-24 with Su-32s.

http://propro.ru/flankers/htm/su-32.htm

http://www.sci.fi/~fta/Su-30.htm

The Swedish airborne early warning radar aircraft (S 100B Argus) was also on display. This system has a 10-meter long active phased array antenna mounted in line with the fuselage. The antenna has approximately 200 T/R modules, and weighs 900 kg. The rest of the radar hardware (signal processor, exciter/receiver, and console) weighs 300 kg. The radar operates in S-band (3 GHz), and claims a lookdown range of 150 km against cruise missiles, and a detection range of 350 km against fighter-sized targets. Six of these aircraft have been operational in Sweden since 1999. Brazil also purchased 5 of these aircraft, and Greece purchased 4.

Major Tim Lawrence
Space Technology

Conference: 5th Conference on Small Satellites Systems and Services, La Baule, France. EOARD was a sponsor of the 5th International CNES (French Space Research Center) Small Satellite Systems and

Services Conference. The conference had 8 technical sessions with over 400 participants from 25 nations. The technical sessions included

- Results and Feedback from Experiments,
- Launch Services,
- Satellite Architectures,
- Methods and tools,
- Small Satellite Technologies, and
- Missions under development/Future missions.

Brief highlights from the many interesting results presented at the conference follow. Please contact me if you would like copies of any papers.

In the keynote session, Joel Barre, CNES programs director, announced the recent developments in small satellites. CNES currently has nine microsatellites under development in the 100 - 120 kg range for launch on the Ariane V. The goal in these programs is to produce two per year with costs under 100 M French Francs (US $12M) each. CNES is hoping to collaborate internationally and is currently discussing building a constellation of satellites with Brazil. Dr Barre proposed at this conference that interested countries should form a steering committee by the end of 2000. CNES is prepared to contribute in satellite design, launch, and ground operations if international partners are interested.

Niels Jensen, Head of European Space Agency's (ESA) Technology and Studies Department, announced that ESA is funding 750 M Euros (US $680M) in its technology program this year. Their interest is to use the Probus I and II satellites to demonstrate formation flying, solar sails, and aerobraking. Dr Jensen suggested that ESA would be interested in participating in the CNES international collaboration program.

In the Results and Feedbacks from Experiments session, DLR (German Aerospace Center) presented recent flight results from Tubsat. One of the intriguing results announced was their ability to control the spacecraft attitude with a Personal Computer mouse with 2 degrees per second. They produced 3 reaction wheels that weigh 1 kg, consume 1 W of power, and have 20 N-m of torque. The Spanish presented results from their 300 kg Minisat. They are claiming the best database for earth atmospheric glow, 350 - 1100 Angstroms at an approximate altitude of 560 km.

The South Africans announced their plans to build SUNSAT II. Their proposal would like this to be a collaborative mission to demonstrate 4-m resolution from an 800-km sun synchronous orbit on a 100-kg microsatellite. This mission is proposed as a follow-on to Sunsat I where they demonstrated 15-m resolution and are claiming it is the best in the world for this small of a spacecraft. They are in discussions with the US, Denmark, the Netherlands, Germany and Korea about this mission.

The University of Surrey presented results from one of their latest missions, UoSAT-12. This 300-kg satellite produced remote sensing results of 30-m multi-spectral and 10-m resolution. They fired a nitrous oxide resistojet to allow repeat ground tracks. They also announced that UoSAT-12 was given an active IP node on the Internet and messages were delivered to and from NASA Goddard. They also mentioned that the SNAP 7-kg nanosatellite and Tsingua-1 45-kg microsatellite would be flying soon. They also have proposed missions for constellations - Rapid eye with the Germans, Gemini Geo Com with the UK, and MMS with NASA Goddard.

ESA presented its SMART-1 mission from GTO to lunar orbit. They plan on using the PPS 1350 Stationary Plasma Thruster operating at 1100 and 480 W to supply the needed delta V. They do plan on flying a diagnostic package on board which includes: langmuirprobe + retarding potential analyzer, contamination sensors, deposition of ions sensor, erosion and sputtering crystal for the solar arrays. The planned launch is for 2002. They also presented plans for SMART-2, which will be another 500-kg bus to do a scientific mission. It is still in the planning stages but one of the mission goals is to fly FEEP (Field Emission Electric Propulsion) thrusters.

In the launch services for small satellites the Leolink launcher was discussed. It is a collaborative program between with Israel Aircraft Industries (IAI), Matra Marconi Space (MMS) in France, and CRC in the USA. It is based upon the existing Israeli SHAVIT launcher. They plan on launching from the Alcantara launch pad in Brazil on a series of 3 launchers, starting with 350 kg in elliptical orbits and ending with 800 kg in circular polar orbits. The first test flight is planned for the end of 2001.

The Russian/French Starsem launcher was discussed in another paper. The Samara Space Center owns 25% of this launcher; the Russian Space Agency has 25%; MMS has 35 %, with the remainder held by Arianespace. Starsem is based upon the Soyuz launcher with an added 4th stage to increase the

payload fairing diameter to 4.0 m. The first launch is planned for the 3rd or 4th quarter of 2001.

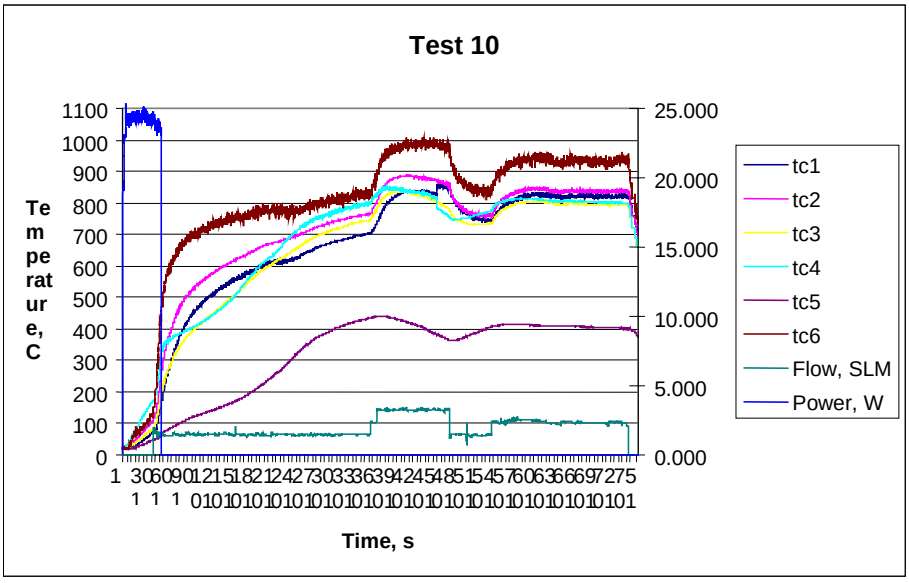
Meeting: Observe Tsingua-1 and SNAP commissioning, University of Surrey, Guildford, United Kingdom, 29 June 2000. The primary host and POC was Dr. Jeff Ward, who presented the latest developments in the 7-kg nanosatellite called SNAP, launched the week before. Following separation from the main Nadezhda satellite, the 38.4 kbps S-band downlink was activated and excellent signals were received at Surrey. The on board computer was loaded successfully and first telemetry indications from SNAP showed a rapid random tumbling motion of about 5 rpm (30 deg/sec) and a magnetorquer rate damping controller, using the new SSTL designed magnetorquer rods, was enabled. Within one day the initial high tumbling motion was completely damped in the X and Z axes and a low Y-rate of 2 rotations per orbit reached - the nadir pointing facet (+Z) of SNAP is now tracking the B-field direction almost perfectly. This low Y-Thomson rate ensures a good down link during ground station passes and a positive power budget.

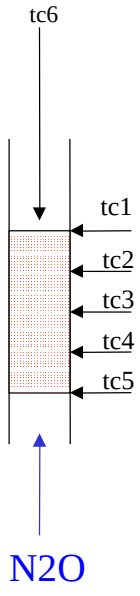
Perhaps most exciting of all was the downloading of the sequence of 60 images automatically taken as the SNAP-1 nanosatellite separated from the Russian Nadezhda military satellite and stored on board. The sequence shows Nadezhda very clearly and then the subsequent deployment of the Tsinghua-1 microsatellite 8 seconds later. This was achieved by using the four miniature CMOS cameras on SNAP-1 and the on-board Machine Vision System: the images are somewhat reminiscent of Apollo-11 days as the cameras struggle with the extremely high contrast between the bright sunlit satellites and the pitch blackness of the deep space background. This is the first time that an SSTL satellite has imaged another spacecraft in orbit - a remarkable achievement.

Future plans include demonstrating 3 axis control and then firing the propulsion system.

Meeting: Review AFRL/PRRS water resistojet endurance test data, University of Surrey, Guildford, United Kingdom, 13 July 2000. The primary host and POC was Dave M Gibbon, who discussed their recent propulsion results. I have discussed Surrey's propulsion program in previous Eurogram articles. Surrey is researching nitrogen and butane cold gas, nitrous oxide and water resistojets, nitrous oxide monopropellant, vortex flow hybrids, and hydrogen peroxide storage with applications to hybrid and bi-propellant propulsion systems. Surrey has flown the cold gas and resistojet systems on UoSAT-12 and SNAP. Surrey researchers are continuing to make progress in their investigation of the nitrous oxide monopropellant system, and have conducted 72 tests with the rhodium catalyst to date. One typical test result is plotted below. Surrey continues to build small satellites; hence the continuing high activity level in low-cost propulsion.

Meeting: Attend discussions with Polyflex Ltd. on propulsion system research, Cheltenham, United Kingdom, 19 July 2000. The primary host was Mr. Malcolm Paul, who guided me through my second tour of Polyflex facilities. This 60-person company works on aerospace expulsion systems and has set up a marketing agreement with MU systems in the US, where interest is high for Polyflex's advances in building xenon systems for ion and Hall thruster systems.





SLM – standard litres a minute

CONFERENCE SUPPORT

EOARD promotes technical interchange by supporting and co-sponsoring technical workshops and mini-symposia at overseas conferences. We often receive, in return for sponsorship, proceedings and free conference registration for one or more Air Force representatives. Air Force R&D personnel attending or considering attending European conferences or seeking further details on the conferences listed below contact the program manager indicated (see footnotes). **Bi-service and tri-service support efforts** are in bold print.

Dates (2000)	*Location*	*Conference/Workshop Title*	*PM*[1]
3 - 4 Sep 00	**Poznan, Poland**	**US/European Celestial Mechanics Workshop www.astro.amu.edu.pl/Science/Conference**	**TL**
4 - 7 Sep 00	Bucharest, Romania	6th Conference on Optics: "Romopto 2000" www.romopto.inoe.ru	CMS
11 - 13 Sep 00	St. John's College,Oxford, UK	Microwave Photonics 2000 www.iee.org.uk/Conf/MWP2000/	DMB
11 - 14 Sep 00	Barcelona, Spain	COMPLAS 2000 Computational Plasticity www.cimne.upc.es/eccomas	RSF
11 - 15 Sep 00	**Split, Croatia**	**36TH International Applied Military Psychology Symposium www.morh.hr/iamps**	**RR**
11 - 14 Sep 00	Barcelona, Spain	European Congress on Computational Methods in Applied Sciences and Engineering www.cimne.upc.es/eccomas	CNR
12 - 15 Sep 00	Kharkov, Ukraine	International Conf on Mathematical Methods in Electromagnetic Theory	CR
17 - 19 Sep 00	Gunzburg Germany	10th European Heterostructure Technology Workshop European Heterostructure Technology Workshop	CR
18 - 22 Sep 00	Florence, Italy	XIII Int'l Symposium on Gas Flow & Chemical Lasers and High Power Laser Conference	CMS
18 - 22 Sep 00	Katseveli, Crimea, Ukraine	Materials and Coatings for Extreme Environments Performance	RSF
18 - 25 Sep 00	University of Oxford, Oxford UK	International Workshop on Materials Modeling (MML 2000) www.users.ox.ac.uk/~mml2000/	RSF
18 - 22 Sep 00	Zvenigorod, Russia	Fourth International Workshop on Microwave Discharges: Fundamental and Applications www.fpl.gpi.ru/md	CNR
20 - 22 Sep 00	Kiev, Ukraine	Organized Vortical Motion as a basis for Boundary-Layer Control www.iprinet.kiev.ua/vortex .htm	CNR
24 Sep - 3 Oct 00	Yerevan, Armenia	Cellular Mechanism of Beneficial and Harmful Effects of Electromagnetic Fields	RR
25 - 27 Sep 00	Pisa, Italy	Condition-Based Maintenance for Highly Engineered Systems	RSF
27 - 29 Sep 00	Amsterdam	How eye movements serve the needs of vision in the natural world	GTO
2 - 4 Oct 00	**Rethymnon, Crete**	**High Power Electrochemical Sources www.iusti.univ-mrs.fr/battery/battery.html**	**CNR**
2 - 6 Oct 00	Crimea, Ukraine	Singular Optics: Fundamentals & Applications	CMS
9 - 13 Oct 00	Zakopane, Poland	Int'l Conf. On Solid State Crystals - Materials Science and Applications	CMS
10 - 12 Oct 00	Kiev, Ukraine	Welded Structures 2000	RSF
16 - 18 Oct 00	**Cranfield, UK**	**Medical and Engineering Aspects of Dynamic Head and Neck Injuries**	**RR**
25 - 27 Oct 00	Leganes-Madrid, Spain	Learning 2000	CR
11 - 12 Dec 00	**Birmingham, UK**	**Titanium Alloys at Elevated Temperature www.materials.org.uk**	**RSF**
12 - 15 Dec 00	Autrans, France	Biosensors, Biochips, & Nanobiotechnologies	RR
16 - 20 May 01	St. Petersburg, Russia	Mathematical Methods, Models and Architectures for Computer Networks Security	CR
20 - 25 May 01	Capri, Italy	Optimization in Composite Material Design and Structural Integrity	RSF
28 - 29 May 01	Prague, Czech Republic	COIL R&D Workshop, Prague 2001	CMS
16 - 20 Jul 01	University of Huddersfield	Algorithms for Approximation IV (A4A4) www.helios.hud.ac.uk/a4a4	CR

[1] CMS-Martin Stickley; CNR-Charbel N. Raffoul; CR-Chris Reuter; DMB- David M. Burns; GTO-Gerald T. O'Connor; JAH-Jay A. Howland; RR-Ron Reed; RSF- Robert S. Fredell;TL-Tim Lawrence

WINDOW ON SCIENCE

EOARD initiates and promotes technical liaison between Air Force and foreign scientists very effectively with the Window On Science (WOS) program, through which we can arrange and fund visits of foreign scientists to selected Air Force facilities. To nominate a WOS candidate, contact your Technical Director or your EOARD discipline representative. WOS visitors currently on contract are listed below. For further details contact the program manager indicated (see footnotes). **Bi-service and tri-service coordinated visits are in bold print.**

Dates (2000)	*Traveler*	*Country*	*Topic*	*Location(s) of Visit*[1]	*PM*[2]
3 - 9 Sep 00	Dr. Michael Oschwald	Germany	Liquid Chemical Combustion Engine Design and Test Diagnostics	Edwards AFB, CA	TL
4 - 10 Sep 00	Professor Friedrich U vonZahn	Germany	Optical Remote Sensing	HRS	TL
9 - 16 Sep 00	Dr. Christopher J. Solomon	United Kingdom	Modeling adaptive optics systems	AFRL/DEBS, Kirtland AFB, NM	CMS
9 - 19 Sep 00	Dr. Svitlana V Berdyugina	Finland	Astronomy and space environment characterization	AFRL VSBS, Sunspot, NM.	TL
9 - 16 Sep 00	Dr. Shlomo Arnon	Israel	Laser satellite communication networks	AFRL/DE, Kirtland AFB, NM; AFRL/IF, Rome, NY; State University of New York (SUNY), Binghamton	CR
10 - 27 Sep 00	Prof. Dr. Alexey Ustinov	Germany	Applied Superconductivity	HRS, MIT, NRL, Applied Superconductivity Conference, Virgina Beach	CR
12 - 19 Sep 00	Dr. Nadejda Kiselyova	Russia	Modeling of inorganic materials	Inorganic Materials Conference, Santa Barbara, CA., AFRL/ML Wright-Patterson AFB, OH	RSF
16 Sep - 1 Oct 00	**Dr. Andre Ionine**	**Russia**	**Overtone CO lasers**	**Florence, Italy**	**CMS**
16 - 29 Sep 00	Dr. Hamid Reza Kokabi	France	superconductivity	1. Applied Superconductivity Conf -- Virginia Beach, VA (17-22 SEP); 2. Hanscom Research Site (24-27 SEP); 3. AFOSR Headquarters-- Washington DC (28 SEP)	DMB
23 - 28 Sep 00	Dr. Yury Nozhnitsky	Russia	Condition Based Maintenance of Highly Engineered Systems	Pisa, Italy.	CNR
23 - 28 Sep 00	Dr. Lambertus Sluys	The Netherlands	modeling of concrete under high strain rates	Munitions Directorate, Eglin AFB	RSF
23 - 27 Sep 00	Dr. Jakob Weerheijm	The Netherlands	modeling of concrete under high strain rates	Munitions Directorate, Eglin AFB	RSF
24 - 26 Sep 00	Dr. Vladimir Kim	Russia	Low Power Stationary Plasma Thrusters	USAFA, Colorado;	TL
27 Sep - 1 Oct 00	Dr. Alexander Nesterenko	Russia	Low Power Stationary Plasma Thrusters (SPT-17 and SPT-20)	Edwards AFB, California.	TL
27 Sep - 9 Oct 00	Dr. Boris Arkhipov	Russia	Low Power Stationary Plasma Thrusters (SPT-17 and SPT-20)	Edwards AFB, California.	TL
27 Sep - 9 Oct 00	Dr. Vladimir Murashko	Russia	Low Power Stationary Plasma Thrusters (SPT-17 and SPT-20)	Edwards AFB, California.	TL
29 Sep - 6 Oct 00	**Dr. Boris Farmakovskiy**	**Russia**	**High Power Electrochemical Sources; Batteries**	**Rethymnon, Crete**	**CNR**
29 Sep - 6 Oct 00	**Dr. Alexander Kuranov**	**Russia**	**High Power Electrochemical Sources; Batteries**	**Rethymnon, Crete**	**CNR**
30 Sep - 5 Oct 00	Dr. Nadejda Kiselyova	Russia	Materials Modeling	Artificial Intelligence in Real Time Control 2000 Conference, Budapest, Hungary	RSF

Dates (2000)	*Traveler*	*Country*	*Topic*	*Location(s) of Visit*[1]	*PM*[2]
1 - 10 Oct 00	Mr. Geoffrey Turner	South Africa	pulsed power applications	US Army SMDC, Huntsville, Al. And Texas Tech University, Lubbock, Tx	JAH
7 - 14 Oct 00	Professor Francois Kajzar	France	"Light and E-field induced movement of molecular subunits in rotaxanes"	AFRL/VSSE, Kirtland AFB, NM, the US Air Force Academy, Colorado Springs, CO, and SUNY Buffalo, Buffalo, NY	CMS
8 - 27 Oct 00	**Professor John Peter Fielding**	**United Kingdom**	**Aircraft Conceptual 7 Preliminary Design**	**AFRL/VASD; AIAA/SAE World Aviation Congress at San Diego**	**CNR**
12 - 14 Oct 00	Dr. Anthony Nicholson	United Kingdom	Assist AFOSR Scientific Advisory Board on chronobiology	University of Pennsylvania, PRET Center Conference on Chronobiology	
13 - 21 Oct 00	Dr. Saidiislam Kurbanov	Uzbekistan	Determining purity of optical materials	Boulder, CO and U of New Mexico, Albuquerque, NM.	CMS
14 - 20 Oct 00	**Dr. Anatoli A Orlov**	**Russia**	**Optical Diagnostics-Pressure Sensitive Paint**	**NASA, Langley**	**CNR**
14 - 21 Oct 00	Dr. Christine Ines Frank	Germany	Numerical simulation of crystal growth	AFRL/SN, Hanscom AFB, MA	CMS
15 - 24 Oct 00	Dipl. Ing Walter Volker Fleck	France	Magnetic sensors for munitions applications	Munitions Directorate (Eglin AFB), FL	CNR
15 - 22 Oct 00	Mr. John Firth	United Kingdom	Challenges & opportunities in aviation neurology: brain monitoring in man	AFRL/HEPA, Wright-Patterson AFB, Ohio.	RR
22 - 25 Oct 00	Dr. Elca Touitou	Israel	Autoradiographic quantification of skin exposures to jet fuels	AFRL/HEST, Wright-Patterson AFB, OH.	RR
29 Oct - 8 Nov 00	Mr. Karl Schulmeister	Austria	Probabilistic risk assessment for high-energy laser safety	AFRL/HEDO, Brooks AFB, Texas.	RR
1 - 10 Nov 00	Dr. Dieter Sporn	Germany	High-performance oxide fibers	AFRL/ML, Wright-Patterson AFB OH; NASA Glenn, Cleveland OH; 3M, Minneapolis MN	RSF
10 - 15 Nov 00	Dr. Constantinos Soutis	United Kingdom	Compressive strength of polymeric composites	USAF Academy CO	RSF
11 - 15 Nov 00	Dr. Louis Neil McCartney	United Kingdom	Composite Mechanics	USAF Academy, CO	RSF
11 - 18 Nov 00	Professor Paul Smith	United Kingdom	Composite Mechanics	USAF Academy CO	RSF
11 - 15 Nov 00	Professor Ryszard Pyrz	Denmark	Composite Mechanics	USAF Academy CO	RSF
11 - 15 Nov 00	Dr. Andrejs Krasnikovs	Latvia	Composite Mechanics	USAF Academy, CO	RSF
12 - 15 Nov 00	Professor Janis Varna	Sweden	Composite Mechanics	USAF Academy, CO	RSF
14 - 18 Nov 00	Dr. Willem Bles	The Netherlands	Attend conference on spatial disorientation	AFRL/HE, Brooks AFB, TX	RR
2 - 8 Dec 00	Dr. Roustam Kaibychev	Russia	Titanium alloys	THERMECH 2000 Conference Las Vegas NV	RSF
2 - 8 Dec 00	Dr. Orest Ivasishin	Ukraine	Grain growth in alpha/beta titanium alloys	THERMECH 2000 Conference Las Vegas NV	RSF

[1] AFRL Research Sites–**ARS**: Armstrong Research Site, Brooks AFB, TX; **ERS**, Edwards Research Site, Edwards AFB, CA **HRS**: Hanscom Research Site, Hanscom AFB, MA; **PRS**: Philips Research Site, Kirtland AFB, NM; **RRS**, Rome Research Site, Rome, NY; **WRS**: Wright Research Site, Wright-Patterson AFB, OH; Other sites: **AEDC**: Arnold Engineering Development Center, Arnold AFB, TN; **USAFA**: Air Force Academy, Colorado Springs, CO; **ARL**: Army Research Laboratory

[2] CMS-Martin Stickley; CNR-Charbel N. Raffoul; CR-Chris Reuter; DMB-David M. Burns; GTO-Gerald T. O'Connor; JAH-Jay A. Howland; PJO-Peter J. Ouzts; RR-Ron Reed; RSF-Robert S. Fredell; TL-Tim Lawrence

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Joint Points of Contact

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